

Space-Time Variations in Surface Currents Over the Oregon Continental Shelf Mapped Using HF Radar

A component of the Oregon State University National Oceanographic Partnership Program on
"Prediction of Wind-Driven Coastal Circulation"

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LONG-TERM GOALS

To determine the factors that produce spatial and temporal variability in currents over the continental shelf and slope, in order to increase their predictability.

OBJECTIVES

To measure the degree of spatial variation in surface currents over the continental shelf in an area, initially 50km square, with strong wind forcing and significant topographic variation, over a range of time scales.

APPROACH

An array of SeaSonde HF radars have been deployed at sites along the Oregon coast, to map surface currents over an area presently 50 km square. Radar coverage encompasses the Newport Hydrographic Line at 44.7°N, which has a long time-series history and which is being sampled monthly by small boat and seasonally by research vessel under other components of this NOPP and under GLOBEC. An upward-looking Doppler profiler near the 80m isobath is measuring vertical profiles of subsurface currents near the center of the array, to provide ground truth for the radar measurements and to study the relationship between surface and subsurface currents. This system has been in place since November 1997. Activity has begun under other components of the NOPP to greatly expand the suite of measurements taken in conjunction with the radar, and to incorporate these measurements into a nowcast/forecast system for wind-driven coastal ocean flow fields which includes modeling and data assimilation.

WORK COMPLETED

Data from the 2-site HF array have been collected since November 1997, under combined ONR and NSF funding. At the southern site, an existing Oregon Park Service building was adapted to house the computers and electronics; at the northern site, a secure structure was built and power and phone lines installed. Partially-processed data are transferred automatically from the field sites to a computer at OSU, where they are processed into vector current maps. Data comparisons between the Acoustic Doppler Profiler currents and those from the HF radar have been made, and initial time-series analyses of the radar-mapped currents has focussed on seasonal and wind-driven timescales.

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RESULTS

The surface currents, from HF radar, compare as expected with 10m currents, measured by a Sontek ADP -- the signals are coherent at subtidal frequencies and around the tidal peaks, subtidal currents are correlated at (0.84, 0.94) for (eastward, northward) currents respectively, and differences have standard deviations of about 10 cm/s in each component. Measured current fluctuations have a strong barotropic component, so the variability in the radar fields is related to the subsurface fluctuations.

Seasonal averages of the currents over the shelf are generally aligned with the isobaths, and show the anticipated seasonal reversal from poleward currents in the winter to equatorward currents in the summer (Figure 1). The mean currents vary strongly across the shelf in both seasons. During winter, mean currents are intensified in water depths of less than about 60m, and also in the northern part of the study area. The nearshore current jet appears to be buoyancy-driven by winter runoff; coincident hydrographic data indicate that the jet is associated with a zone of fresh surface water. The acceleration of the mean currents to the north takes place where the shelf isobaths converge; this appears to be a consequence of potential vorticity conservation, which favors along-isobath flow, together with the conservation of mass and weak vertical shear, requiring the flow to speed up as it enters a narrower "pipe".

The summer average current (Figure 1, right panel) shows the seasonal alongshore current jet, which is expected to flow equatorward along the front between upwelled water inshore and warmer oceanic water offshore. The core of the average jet is centered near the 80m isobath, about 15km offshore, as it enters the study region in the north. As it flows southwestward, the core moves offshore somewhat more rapidly than the isobaths do, so that it is centered near the shelf break when it exits the domain at its western edge. The average surface currents in the core of the jet are strongest in the region of Stonewall Bank, near 44.6°N, 124.4°W. Inshore of the bank, away from the jet and the inferred front, the mean currents are very weak.

Fluctuations in the currents, shown as ellipses in principal axes, tend to show any polarization along the underlying isobaths (Figure 2). Current fluctuations were stronger during winter than during summer. Winter fluctuations showed strong spatial variability, with those in the north a factor of 2 stronger than those in the south. During summer, the current fluctuations were much weaker inside of the 80m isobath (inshore of the coastal front). The relationship between these fluctuations and wind forcing is being investigated.

IMPACTS AND APPLICATIONS

Coastal HF radar is providing us with a tool to obtain time-series observations of spatially varying currents over the continental shelf and inner slope, allowing us to image narrow, coastally-trapped buoyancy driven flows, flows along coastal fronts, and the interaction of currents with topography. The energy in the relatively small-scale alongshore variations in flow properties is surprising, and will provide interesting statistical test cases for evaluating models of coastal circulation.

RELATED PROJECTS

These results have been of interest to the coastal circulation modelers in the OSU NOPP. The US GLOBEC Long Term Monitoring Program, which is making repeated hydrographic sections along the Newport Line at 44.7°N, benefits from these measurements. In addition, several OSU investigators have programs making measurements locally over the continental shelf (J. Moum; T. Cowles) and we are working with them to provide a spatial context to the ship-based measurements of turbulent dissipation and microlayer formation that they are conducting, respectively.

PUBLICATIONS

Kosro, P. M., 1998. (Almost) a year of surface current mapping from Newport, Oregon. Presented at 45th Annual Eastern Pacific Ocean Conference, Timberline, Oregon.

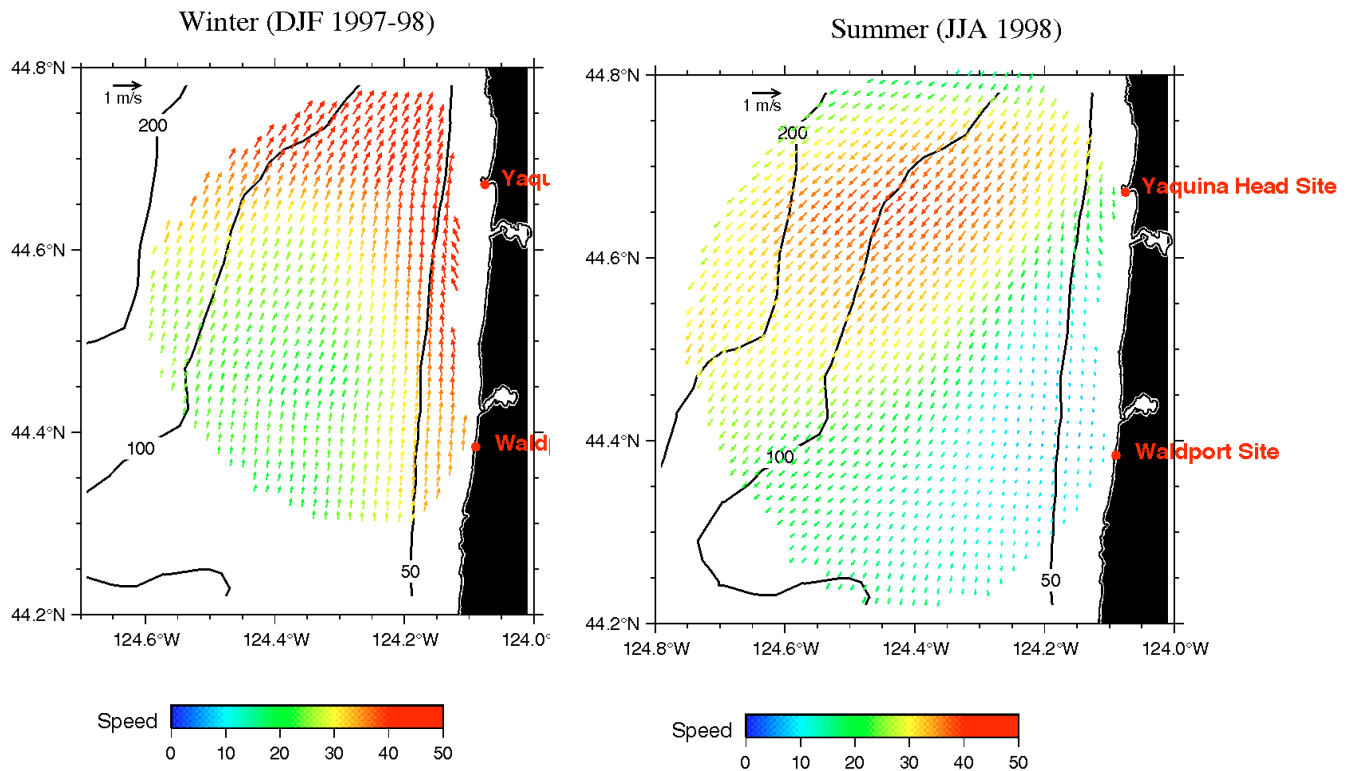


Figure 1. Seasonal average currents during winter (December 1997 through February 1998) and summer (June 1998 through August 1998), from HF radar measurements.

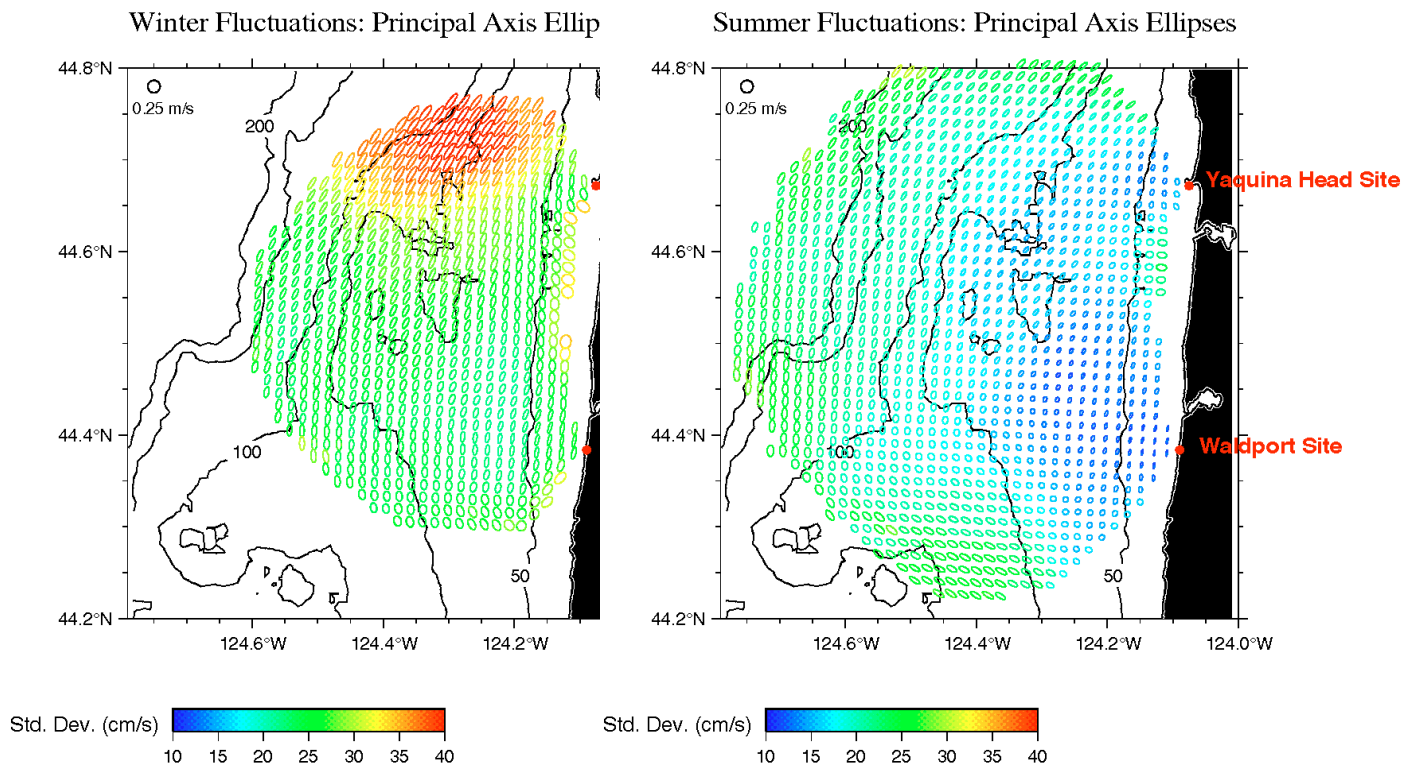


Figure 2. Standard deviation ellipses resolved into principle axes, for winter and summer data sets.